REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, the independent claims presently being considered on the merits in the above-identified application have been amended to recite that the gas atmosphere in which the plasma etching treatment is performed contains, in addition to the fluorocarbon-gas-containing etching gas, an argon gas as a carrier gas, and a nitrogen gas so as to avoid forming a sub-trench. Note, for example, pages 72-75 of Applicants' Substitute Specification submitted with the Preliminary Amendment filed April 5, 2001, in the above-identified application (hereinafter "Substitute Specification").

Moreover, Applicants are adding new claims 42 and 43 to the application. Claims 42 and 43, dependent respectively on claims 1 and 42, define the flow rate at which the nitrogen gas is provided during the plasma etching treatment, consistent with the description on pages 79 and 80 of Applicants' Substitute Specification.

Indication by the Examiner in Item 2 on page 2 of the Office Action mailed May 21, 2004, that claims 22-24 have been withdrawn from further consideration as being drawn to a nonelected invention, is noted. Claims 22-24 are being retained as withdrawn claims in the above-identified application, subject to the filing of a Divisional application or applications based thereon in due course.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner on the merits, patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed May 21, 2004, that is, the teachings of U.S. Patent No. 6,669,858 to Bjorkman, et al., under the provisions of 35 USC §102 and 35 USC §103.

It is respectfully submitted that this reference as applied by the Examiner would have neither taught nor would have suggested such a manufacturing process of a semiconductor integrated circuit device as in the present claims, including the plasma etching treatment, with such plasma etching treatment being conducted in a gas atmosphere containing a fluorocarbon-gas-containing etching gas, argon gas as a carrier gas, and a nitrogen gas so as to avoid forming a sub-trench. See claim 1. Note also, e.g., claims 5, 13, 25, 30, 36, 38, 40 and 41.

Furthermore, it is respectfully submitted that the applied reference would have neither disclosed nor would have suggested additional features as in the above-referred-to claims, having the plasma etching treatment of the insulating film including as a main component an organosiloxane, and wherein the insulating film subjected to the plasma etching treatment is a second etching film formed over a first etching film, the second insulating film including as a main component a second organosiloxane which has a smaller carbon content than the first organosiloxane (see claim 5; note also, inter alia, claim 30); and/or wherein the process includes first and second plasma

etching treatments in respective gas atmospheres containing argon gas as a carrier gas, a fluorocarbon-gas-containing etching gas, and a nitrogen gas so as to avoid forming a sub-trench (see claim 13; note also, inter alia, claim 36); and/or a dual-damascene processing as in, inter alia, claims 36, 38 and 40.

In addition, it is respectfully submitted that the teachings of the applied reference would have neither disclosed nor would have suggested the additional features of the remaining dependent claims being considered on the merits in the above-identified application, including, inter alia, wherein the gas atmosphere contains an oxygen gas (see, e.g., claims 3 and 27), or wherein the gas atmosphere is substantially free of an oxygen gas (see, e.g., claims 4 and 28); and/or relative thicknesses and relative carbon contents of the first and second insulating films as in, for example, claims 6-8, 23, 24 and 31-33; and/or thickness of the second insulating film after the plasma etching treatment of the second insulating film in the first gas atmosphere, as in claims 14-16; and/or wherein the first insulating film includes silicon nitride as a main component (see. e.g., claims 17, 26 and 39); and/or wherein the first gas atmosphere contains argon gas as the largest gas component (note claim 1; see also claim 27); and/or etching selectivity as in claims 34 and 35.

The present invention, as claimed in the above-identified application, is directed to a process for manufacturing a semiconductor integrated circuit device, particularly effective when adapted to a multilevel metallization process in the manufacture of a semiconductor integrated circuit device.

As element integration of semiconductor integrated circuit devices has increased, multilevel fabrication of interconnects have been utilized. However, with multilevel interconnect structure, wiring delay occurs, which strongly influences the signal delay of the whole semiconductor integrated circuit device. It is necessary to reduce wiring resistance and wiring capacitance, for obtaining a decrease in the wiring delay. In order to reduce wiring capacitance, a technique employing as an insulating film, an organic spin-on-glass film, can be employed; and for decreasing wiring resistance, a damascene process using a copper-based material as a wiring material has been employed. Note pages 1-4 of Applicants' Substitute Specification. However, various problems arise in connection with the various damascene processes and in connection with using an organic polymeric insulating film, as described on pages 4 and 5 of Applicants' Substitute Specification.

Moreover, the present inventors have found that in forming a trench or hole by a highly-selective etching treatment using, as an etching gas, a fluorocarbon-based gas and O_2 gas, a problem inevitably occurs in that a sub-trench relatively deeper than the depth at the bottom center of the trench is formed at the outer periphery of the bottom of the trench or hole. Note the paragraph bridging pages 5 and 6 of Applicants' Substitute Specification. Note also the description of the sub-trench in Item 10 in lines 9-14 on page 67 of Applicants' Substitute Specification. While use of an etching gas having low selectivity avoids the problem of such sub-trench, of course this raises additional problems due to such low selectivity which requires an increase in

the thickness of the insulating film serving as an etching stopper, resulting in a problem of increase in total dielectric constant of the interconnects.

Against this background, Applicants provide a process wherein such sub-trenches can be avoided, without a substantial lowering of the selectivity of the etching process. Applicants have found that by including a nitrogen gas so as to avoid forming a sub-trench, together with a fluorocarbon-gas-containing etching gas, and argon gas as a carrier gas, selectivity for the organosiloxane insulating film is maintained, while avoiding the forming of a sub-trench. Note, for example, pages 72-78 of Applicants' Substitute Specification, together with Fig. 7; see also Fig. 9 and the description in connection therewith on pages 79 and 80 of Applicants' Substitute Specification.

As for advantages achieved according to the presently claimed invention, note, for example, pages 164-166 of Applicants' Substitute Specification. In this regard, note that according to the present invention, etching selectivity of the various insulating films can be modified by changing carbon content thereof; and it is possible to use an insulating film including organosiloxane as a main component, as an etching stopper.

Bjorkman, et al. discloses a process and apparatus for depositing and etching dielectric layers on a substrate. In a first preferred dual damascene embodiment, a first low k dielectric layer and a second low k dielectric layer are deposited on a substrate, for subsequent etching of vertical and horizontal interconnects. The first dielectric layer is an etch-stop layer that contains

silicon, oxygen, carbon and hydrogen; and the second dielectric layer preferably contains less than two-thirds of the carbon or less than one-fifth of the hydrogen contained in the first dielectric layer. The vertical and horizontal interconnects are then etched into the low k dielectric layer using fluorocarbon gases. A carbon:oxygen compound, such as carbon monoxide, is added to the fluorocarbon gases during etching of vertical interconnects, and is not used during etching of horizontal interconnects to obtain an etch selectivity of at least 3:1. The horizontal and vertical interconnects can then be filled with a conductive material such as copper. See column 3, lines 20-40. Note also column 6, lines 46-49, disclosing etching using a mixture of gases including argon and one or more gases selected from CF_4, C_2F_6, and C_4F_8. Note also column 7, lines 2-5 and column 8, lines 47-50, also disclosing the mixture of gases used during the etching. This patent discloses that the etching process therein provides high etch rates and highly selective etching of the dielectric layers on the substrate, with the process gas used in the etching process comprising (i) fluorocarbon gas for etching the dielectric layer and forming passivating deposits on the substrate; (ii) carbon-oxygen gas for reducing formation of passivating deposits, and (iii) argon or nitrogen-containing gas for removing the passivating deposits on the substrate. Note column 15, lines 56-63. See also the paragraph bridging columns 15 and 16; and column 17, lines 3-13.

It is respectfully submitted that Bjorkman, et al. does not disclose, nor would have suggested, such a manufacturing process as in the present

claims, including, inter alia, the use of the etching gas including nitrogen gas so as to avoid forming a sub-trench. Again, as discussed previously, and as described in Applicants' specification, Applicants have discovered a problem with respect to disadvantageous formation of sub-trenches; and having discovered this problem, have provided a solution thereto. Particularly in view of the discovery of the problem and discovery of a solution thereto, the presently claimed subject matter patentably distinguishes over the teachings of Bjorkman, et al.

The contention by the Examiner in Item 7 on page 3 of the Office Action mailed May 21, 2004, that Bjorkman, et al. discloses a method which etches organosiloxane low-k films using, inter alia, carrier gases (Ar and nitrogen) is noted. Bjorkman, et al. discloses use of, inter alia, argon as a carrier gas; however, as recognized by the Examiner in Item 8 on page 3 of the Office Action mailed May 21, 2004, nitrogen is mentioned, but only in connection with a gas for removing the passivating deposits on the substrate. See column 15, lines 56-63, especially lines 62 and 63.

More importantly, it is respectfully submitted that the claims as presently amended recite that the gas atmosphere contains, inter alia, a nitrogen gas so as to avoid forming a sub-trench. Clearly, the "mention" of nitrogen-containing gas in column 15 of Bjorkman, et al., for removing the passivating deposits on the substrate, would have neither disclosed nor would have suggested, and in fact would have taught away from, the present

invention, including, inter alia, the nitrogen gas, included with the other gases in the plasma etching treatment, so as to avoid forming a sub-trench.

Reference by the Examiner to U.S. Patent No. 6,660,663 to Cheung, et al., in Item 9 on page 3 of the Office Action mailed May 21, 2004, is noted. It must be emphasized that the Examiner has not applied Cheung, et al. in the formal statement of the rejection; and, more importantly, has not shown motivation for modifying the teachings of Bjorkman, et al. in light of the description of Cheung, et al. Clearly, Cheung, et al. does not form part of the rejection, and no further discussion thereof is necessary. See In re Hoch, 166 USPQ 406, 407 n.3 (CCPA 1970).

Contentions by the Examiner in Items 10 and 11 on pages 3 and 4 of the Office Action mailed May 21, 2004, are noted. As recognized by the Examiner, Bjorkman, et al. provides no disclosure, nor any suggestion, with respect to multiple layers of organosiloxane, much less different layers; and the Examiner has not referred to any evidence with respect to allegations made in these Items 10 and 11. Clearly, the bases for claim rejections as set forth in Items 10 and 11 on pages 3 and 4 of the Office Action mailed May 21, 2004, are improper, without any evidence or proper reasoning in support thereof. See In re McKellin, 188 USPQ 428 (CCPA 1976).

In view of the foregoing comments and amendments, reconsideration and allowance of all claims remaining in the application and being considered on the merits therein, are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR § 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Deposit Account No. 01-2135 (Case No. 501.39082X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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